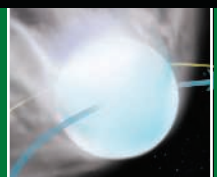

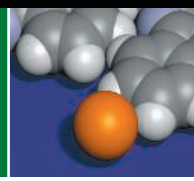

LETTERS

edited by Jennifer Sills

Endangered. The Roti Island snake-necked turtle is one example of a species threatened by wildlife trading.

Redesigning the Wildlife Trade System

K. F. SMITH *ET AL.*'S POLICY FORUM ("REDUCING the risks of the wildlife trade," 1 May, p. 594) aptly proposes the need for a priori restrictions to be placed on newly traded wildlife species to predetermine their environmental, health, and economic impacts. The need for such restrictions is clear for the conservation of these traded species as well. For example, some reptile species collected for the exotic pet trade have been driven to near extinction, or extirpated from their type localities, immediately after their description in the scientific literature (*1*) and before receiving any protection through registration in the Convention on International Trade in Endangered Species (CITES) of wild fauna and flora.

The novelty and potential rarity of newly traded species could result in the occurrence of anthropogenic allele effects (*2*), which may ultimately lead to heavy population declines, even during the time required to process CITES registrations (*3*). Automatically restricting the trade in these species could allow conservation assessments to be undertaken in addition to risk analyses of their potential impact. Given all the knowledge we have accrued about the negative impacts of the wildlife trade, perhaps it would make more sense to adopt a system whereby permissions are sought to include a species in the international trade, rather than requiring hasty applications for limits when it may already be too late.

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References

1. B. L. Stuart, A. G. J. Rhodin, L. L. Grismer, T. Hansel, *Science* **312**, 1137 (2006).
2. F. E. Courchamp *et al.*, *PLoS Biol.* **4**, e415 (2006).
3. P. Rivalan *et al.*, *Nature* **447**, 529 (2007).

Wood Energy: Predicting Costs

THE POLICY FORUM "WOOD ENERGY IN America" (D. deB. Richter Jr. *et al.*, 13 March, p. 1432) was a much-needed and long-overdue contribution to energy discussions. However, fossil fuels are not four times more expensive than wood per unit energy. Rather, most fossil fuels are still less expensive than wood in most places, though the price of wood shows more local variation and is more volatile even than that of fossil fuels. Global mean wholesale price for sawlogs in the first quarter of 2008 was about $170 per metric ton (MT), or about $10/GJ (*1*). The mean wholesale price for pellets then was about $200/MT, or about $11/GJ (*2*). Since then (because of the housing crash), the price of sawlogs has dropped dramatically in the United States (*3*), but the global wholesale price of wood pellets has remained stable (*2*).

At $60/barrel, oil is $10/GJ; natural gas currently is about $4/GJ (*4*). The latest Energy Information Administration projections place the mean cost of coal to U.S. utilities in 2009 at $2/GJ, though high-grade coals can be three times as expensive ($180/MT) (*4*).

The cost of wood seems likely to soar again within a few years. A severe pine-beetle blight began in North America in 1999, and today vast expanses (several gigatons, over 500,000 km^2) of the forests in North America are dead (*5*). These forests (containing over four times as much dead wood as current global wood annual usage) will be largely destroyed by wildfires over the next 6 years. Even in the United States, wood pellets have recently sold for over $320/MT in some areas (*6*), and some projections indicate global wood-pellet usage will continue to grow at over 20% annually for the next decade (*7*). It's hard to image wood pellets being under $400/MT ($22/GJ) by 2013.

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References

1. UNECE Forest Products Annual Market Review, 2007–2008; http://timber.unece.org/fileadmin/DAM/FPAMR2008.pdf.
2. C. Rakos, *Int. Sustainable Energy Rev.* **1**, 142 (2009).
3. Texas Forest Services, *Texas Timber Price Trends*, (January/February, 2009).
4. Energy Information Administration, "Short-term energy outlook" (2009); www.eia.doe.gov/emeu/steo/pub/mar09.pdf.
5. S. W. Running, *Science* **321**, 652 (2008).
6. E. Russell, "Market for pellets tightens," *Bangor Daily News*, 25 September 2008; www.bangordailynews.com/detail/51497.html.
7. Wood Resources International, LLC; www.woodprices.com.

Wood Energy: Protect Local Ecosystems

IN THEIR POLICY FORUM PAPER "WOOD ENergy in America" (13 March, p. 1432), D. deB. Richter Jr. *et al.* argue cogently for deployment of advanced wood combustion (AWC) systems to meet a range of objectives, and they demonstrate the potential economic and energy values of community-based AWC in the United States. The accuracy of their estimates of U.S. energy potential from AWC is dependent, in part, on estimates of wood supply. This includes logging residue (tops, branches, and foliage) from sustainably

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managed forests. However, they do not address what proportion of this residue should be left on-site to sustain local ecosystems over multiple rotations.

Neither of the authors' examples of mid-sized state inventories estimate this proportion (*1*, *2*), yet the U.S. national biomass inventory assumes that 35% of total logging residue produced should be left to allay site impact concerns (*3*); other large-scale logging residue inventories have used reductions of 0% (*4*, *5*), 30% (*6*), 50% (*7*), and 100% (*8*). When proportional reductions are used, these are based on expert opinion and one proportion is applied to all sites within large regions (country, state, province, or land ownership system). Which reduction is most appropriate?

In a recent EU report (*9*), expert opinion was used in a biomass inventory study to define different levels of logging residue retention for each of four site sensitivity classes, based on slope, elevation, and soil properties. The resultant site sensitivity map was then combined with a forest inventory map of the same grid size (1 km by 1 km) to create a spatial layer defining the environmentally compatible potential for logging residue removals that could then be scaled up to large-scale resolution across Europe.

Results show a reduction (for 2000 to 2005) in total logging residue inventory of 39% for the EU-13 and 41% for the EU-21 countries. The similarity in the 13- and 21-country results suggests that, for the soil criteria used and for conditions similar to those in the European Union, a 40% reduction for large-scale inventories would be reasonable. The EU study, however, focuses on soil issues; until similar approaches are applied for other aspects of the ecosystem (such as biodiversity and water quality), using a 50% retention proportion therefore may be appropriate, as in some national studies (*7*).

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References

1. C. D. Ray, "Pennsylvania low-use wood potential" (Pennsylvania State University, State College, PA, 2007); www.outreach.psu.edu/programs/goddard/files/Ray.ppt#256.
2. C. Hopkins, "Potential of biomass to support a renewable portfolio standard in North Carolina" (North Carolina State University, Raleigh, NC, 2006); www.ces.ncsu.edu/nreos/forest/feop/Agenda2006/energy/presentations/hopkins.pdf.
3. R. D. Perlack *et al.*, "Biomass as feedstock for a bioenergy and bioproducts industry: The technical feasibility of a billion-ton annual supply" (DOE/GO-102995-2135 and ORNL/TM-2005/66); available at http://feedstockreview.ornl.gov/pdf/billion_ton_vision.pdf.
4. S. Wetzel, L. Duchesne, M. LaPorte, *Bioproducts from Canadian Forests: New Partnerships in the Bioeconomy* (Springer, Dordrecht, Netherlands, 2006).
5. W. Mabee, E. D. G. Fraser, P. N. McFarlane, J. N. Saddler, *Appl. Biochem. Biotechnol.* **129**, 22 (2006).
6. P. Ralevic, D. B. Layzell, "An inventory of the bioenergy potential of British Columbia" (BIOCAP Canada Foundation, Kingston, Ontario, Canada, 2006); www.biocap.ca/images/pdfs/BC_Inventory_Final-06Nov15.pdf.
7. S. W. Wood, D. B. Layzell, "A Canadian biomass inventory: Feedstocks for a bio-based economy" (BIOCAP Canada Foundation, Kingston, Ontario, Canada, 2003); www.biocap.ca/images/pdfs/BIOCAP_Biomass_Inventory.pdf.
8. J. Etcheverry *et al.*, *Smart Generation: Powering Ontario with Renewable Energy* (David Suzuki Foundation, Vancouver, British Columbia, Canada, 2004); www.davidsuzuki.org/files/Climate/Ontario/Smart_Generation_full_report.pdf.
9. European Environment Agency, "How much bioenergy can Europe produce without harming the environment?" (EEA Report No. 7/2006, 2006); www.eea.europa.eu/publications/eea_report_2006_7/at_download/file.

Wood Energy: The Dangers of Combustion

WE AGREE WITH THE RECENT POLICY FORUM ("Wood energy in America," D. deB. Richter Jr. *et al.*, 13 March, p. 1432) that renewable, clean, and affordable energy sources are desirable; however, there may be detrimental health outcomes associated with widespread adoption of advanced wood combustion (AWC).

Air pollution from wood combustion is associated with a variety of adverse health impacts (*1*), and typical emissions (even from AWC) are significantly higher than those from modern natural gas and fuel oil combustion (*2*). Although pollution control technologies are available, they are not yet consistently applied, even in newer wood boiler installations such as those in the Fuels for Schools program (*3*).

More important, even if emissions from AWC are reduced relative to other sources, the distributed nature of a proposed wood energy system would lead to thousands of small combustion sources in close proximity to population centers, increasing the proportion of harmful emissions that result in human exposure (*4*, *5*). Distributed sources such as AWC would require dramatically lower emissions per unit energy than centralized combustion facilities in order to yield a net reduction in population exposure to air pollution (*6*).

Identifying rational climate-mitigation strategies, whether biomass-related or otherwise, requires integrated assessments that carefully weigh climate and energy security benefits with potential health and other environmental impacts (*7*, *8*).

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References

1. L. Naeher *et al.*, *Inhal. Toxicol.* **19**, 67 (2007).
2. U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, Vol. 1: Stationary Point and Area Sources* (EPA Publication AP-42, ed. 5, 1995); www.epa.gov/ttn/chief/ap42.
3. Fuels for Schools and Beyond (www.fuelsforschools.info).
4. D. Bennett *et al.*, *Environ. Sci. Technol.* **36**, 206A (2002).
5. F. J. Ries *et al.*, *Environ. Sci. Technol.*; available at http://pubs.acs.org/doi/abs/10.1021/es803127d.
6. G. Heath *et al.*, *Atmos. Environ.* **40**, 7164 (2006).
7. E. Mazzi, H. Dowlatabadi, *Environ. Sci. Technol.* **41**, 387 (2007).
8. J. Hill *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **106**, 2077 (2009).

Response

FORESTERS AND LOGGERS FROM AROUND THE United States report that energy wood delivered to market runs from less than $20 to $50 per green Mg (ton) with 50% moisture (*1*), prices that convert to about $2 to $5 per GJ. Doty questions these prices based on a common misunderstanding of how wood is harvested in the forest. Energy wood is merchandized as a low-priced product (not to be confused with much higher priced sawtimber), and thus energy wood thinnings can support forest improvement projects for restoration, conservation, and fire-risk reduction. Our estimates of $2 to $5 per GJ for energy wood include a historic range of low-priced wood products and can be compared with the Energy Information Administration reports that indicate industrial users of natural gas paid nearly $7 per GJ in January 2009 and that the spot price of distillate fuel was almost $10 per GJ in March 2009 (*2*, *3*), far above that of energy wood. Doty's letter illustrates the need for wood-energy

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education, the need for standardized definitions of biomass energy (*4*), and the need to better quantify environmental and social benefits that amplify financial advantages made possible by wood.

Titus and colleagues address wood supply by reviewing estimates for how much energy wood can be recovered from newly logged forests, which is important because sustainability requires that energy-wood harvests not degrade forest ecosystems. Research on harvest impacts on soils is extensive (*5*, *6*), and despite site-to-site variation, Titus and colleagues point to European and North American assessments that 40 to 65% of woody debris left on-site after conventional logging might be marketed as wood energy. These estimates illustrate that the energy-wood supply is enormous, and it is indeed larger still given waste wood from ongoing management of urban forests and the millions of hectares of forests that can be thinned to lower wildfire risks and meet restoration and conservation-forestry objectives. More than abundance alone, our Policy Forum emphasized that wood is too valuable to waste with inefficient combustion and that community-based advanced wood combustion (AWC) systems used for heat, cooling, and power operate at two to three times the efficiency of electricity-generating facilities being planned in response to the Congressionally proposed Renewable Electricity Standard (RES). Burning wood solely for electricity is not AWC as defined in our Policy Forum, given that these facilities will waste 60 to 75% of the energy stored in wood. Such RES-promoted wood electricity helps explain Casten's recent remark that "separate generation of electricity and heat is utter madness" (*7*).

Finally, we heartily agree with Ries and colleagues that integrated assessments can guide society's transition from fossil to efficient and renewable energy systems. Ries and colleagues are concerned, as are we, by health effects of air pollutants from open burning, wildfires, and unregulated stoves and fireplaces. However, none of these combustions qualifies as AWC, which by definition combines high-quality combustion and high-efficiency thermal conversion that together enable systems to strictly control atmospheric emissions. Given the importance of integrated assessments of energy transitions to renewables, Ries and colleagues might be impressed, as are we, with the variety of environmental, economic, and social benefits offered by AWC, including well-demonstrated and ongoing improvements in lowering atmospheric emissions across thousands of systems throughout Europe (*8*, *9*).

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References and Notes

1. Resource Information Systems Inc., *Int. Woodfiber Rep.* **15,** 1 (2009).
2. Energy Information Administration (EIA), *Heating Oil and Propane Update* [U.S. Department of Energy (DOE), Washington, DC, 2009].
3. EIA, *Natural Gas Prices* (DOE, Washington, DC, 2009).
4. D. Hagauer, B. Lang, K. P. Nemestothy, *Instruction Manual for the Calculation of Wood Fuel Parameters* (Austrian Energy Agency, Vienna, 2009); www.klimaaktiv.at/filemanager/download/30205.
5. E. L. Stone, in *Impact of Intensive Harvesting on Forest Nutrient Cycling* (State University of New York, Syracuse, NY, 1979), pp. 366–386.
6. D. D. Richter, D. Markewitz, *Understanding Soil Change* (Cambridge Univ. Press, Cambridge, 2001).
7. D. Lindley, *Nature* **458**, 138 (2009).
8. In Austria, not only are AWC systems officially certified for efficiency and emissions before operations, but official test reports of efficiency and emissions are published on the Internet (http://blt.josephinum.at/index.php?id=653).
9. T. Nussbaumer *et al.*, *Particulate Emissions from Biomass Combustion in IEA Countries* (International Energy Agency, Bioenergy Task 32, Zürich, 2008).

Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 3 months or issues of general interest. They can be submitted through the Web (www.submit2science.org) or by regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

CORRECTIONS AND CLARIFICATIONS

News Focus: "A long, winding road to ignition" (17 April, p. 327). The item reported that the National Ignition Facility's laser beam travels 305 meters in 25 nanoseconds. In fact, it travels 457 meters in less than 2 microseconds.

Letters: "Creating a common climate language" by T. E. Bowman *et al*. (3 April, p. 36). The atmospheric concentration of CO_2 was 379 ppm in 2005, not 397 ppm.

Editors' Choice: "All washed up" (20 March, p. 1539). The photograph should have shown a red tide in California, but instead showed Gay Head, located on Martha's Vineyard in Massachusetts.

News Focus: "Senate majority leader hands NSF a gift to serve the exceptionally gifted" by J. Mervis (20 March, p. 1548). The longitudinal study of mathematically precocious youth, begun in 1971 by Julian Stanley at Johns Hopkins University, is now being carried out by Camilla Benbow and David Lubinski at Vanderbilt University. Linda Brody directs the Study of Exceptional Youth at Johns Hopkins.

News Focus: "A memorable device" by L. Laursen (13 March, p. 1422). On page 1423, neuropsychologist Georgina Browne's name was spelled incorrectly. The misspelling has been corrected online.

TECHNICAL COMMENT ABSTRACTS

COMMENT ON "Tail Reconnection Triggering Substorm Onset"

A. T. Y. Lui

Angelopoulos *et al*. (Research Articles, 15 August 2008, p. 931) reported that magnetic reconnection in Earth's magnetotail triggered the onset of a magnetospheric substorm. We provide evidence that (i) near-Earth current disruption, occurring before the conventional tail reconnection signatures, triggered the onset; (ii) the observed auroral intensification and tail reconnection are not causally linked; and (iii) the onset they identified is a continuation of earlier substorm activities.

Full text at www.sciencemag.org/cgi/content/full/324/5933/1391-b

RESPONSE TO COMMENT ON "Tail Reconnection Triggering Substorm Onset"

Vassilis Angelopoulos, James P. McFadden, Davin Larson, Charles W. Carlson, Stephen B. Mende, Harald Frey, Tai Phan, David G. Sibeck, Karl-Heinz Glassmeier, Uli Auster, Eric Donovan, Ian R. Mann, I. Jonathan Rae, Christopher T. Russell, Andrei Runov, Xu-Zhi Zhou, Larry Kepko

Lui challenges our conclusion that magnetic reconnection triggered the onset of a magnetospheric substorm. However, Lui incorrectly uses the auroral electrojet index instead of ground auroral and magnetic field pulsation signatures to determine substorm onset; single velocity and magnetic field components instead of full vectors and particle distributions to identify reconnection onset; and preliminary auroral electrojet–low index (AL) instead of ground magnometer, auroral, and magnetotail data to claim pre-existing activity.

Full text at www.sciencemag.org/cgi/content/full/324/5933/1391-c